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Using Goal Programming For Transportation Planning Decisions Problem In Imprecise Environment

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Abstract: In this paper, we present a fuzzy goal programming model for Transportation Planning Decisions (TPD) problem. In real-world applications of the transportation planning decisions problems with multi-objective, input data or related parameters are majority vague/fuzzy. It is hard for decision maker(s) to determine the goal value of each objective precisely as the goal values are imprecise. We consider three methods in the research for solving TPD problem under fuzziness, first method is interactive fuzzy goal programming (IFGP), that this approach aim minimizing the worst upper bound to determine an reasonable solution which is end to the best lower bound of each objective function. Second method is fuzzy goal programming, that this procedure proposed a weighted additive model to solve TPD problem which uses flexibility to obtain the priority of fuzzy goals. We will consider Fuzzy Mix Integer Goal Programming (FMIGP) model in TPD problem, using linear membership functions and determining aspiration levels, therefore defuzzify with mix integer mathematical programming model. In last section of solution procedure, this model will solve by the software LINGO (Ver.10.0). Third procedure is interactive fuzzy linear programming (i-FMOLP); the aim of presented i-FMOLP method wills both costs and delivery time possibility minimizes. In this approach performance is experimented by measuring the degree of closeness of the compromise solution to the ideal solution using a family distance functions. In addition, this research shows that the interactive fuzzy linear programming (i-FMOLP) more performance relativity with other procedures.

Key word: Transportation planning decisions (TPD), Interactive fuzzy goal programming (IFGP), fuzzy goal programming, Interactive fuzzy linear programming (i-FMOLP), fuzzy set theory.

INTRODUCTION

The Transportation Planning Decisions (TPD) involve distribution productions and services from set sources (e.g. goods production locations) to a set of destination (e.g. selling locations). The classical TPD problem is one of the under classes of linear programming (LP) can be solved utilizing by standard simplex general method and the stepping stone and the modified distribution special algorithms. Initially, Hitchcock (1989) and Kantorovich (1960) developed a transportation model. Arsham and Khan (1989) developed a simplex type algorithm to solve the general transportation problem. The multi-objective transportation problem (MOTP) in a crisp environment was developed by Isermann H (1979) and Ringuest J L, Rinks (1987). However, when we utilize with simplex procedure for solving TPD problem, we assume whole parameters and variable decisions under deterministic /crisp environments.

In large of particular TPD problems input data, parameters and goals are often vague/ fuzzy owing incomplete unaccepted information. Obviously, standard simplex method and other particular algorithms cannot responsibility for solving TPD problem under fuzzy environment. Firstly, Zimmermann (1976) explores fuzzy sets theory into linear programming (LP) problem with fuzzy objective and constraints. Continually, Bellman and Zadeh (1970) proposed decision making procedures under fuzziness.

Chanas and kutcha (1996) extended the procedure optimum solution of the Transportation Decisions Problem crisp costs and fuzzy supply and demand quantities. Chanas and Kutch (1998) consider Transportation Decisions Problem using by Fuzzy Integer Linear Programming (FILP) procedure. Bit *et al* (1992) applied fuzzy programming approach for solving Multiple-Criteria Transportation Problem. Abd El-Wahed (2006) and Lee consider an interactive fuzzy goal programming technique for transportation problem. Gao and Liu (2004) apply a two-phase method for fuzzy goal programming technique in order to solving multi-objective transportation problem. Pramanik and Roy (2006) discussed the Fuzzy goal programming (FGP) approach for Multi-objective Transportation, with crisp and fuzzy coefficients. Abd El-Wahed (2001) extension a fuzzy approach to obtain the optimal solution for Multi-objective transportation problems. The interactive method has been introduced into this problem and studied by many authors (Sakawa, M., 1993; M.H. Rasmy *et al*., 2002) which requires DM must stand by and make important preferences at each step of the optimization process.

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In the research a Transportation planning decisions problem consider precise and certain goal quantities for objectives. However, it is difficult for the decision-maker(s) to determine the goal quantities of each objective precisely, because the goal values are imprecise in real world conditions.

In this study, a fuzzy goal programming model with an imprecise goal quantity for each objective is extension for the TPD problem. The presented model, which is the first fuzzy multi-objective linear programming approach to the TPD problem, is based on the multi-objective programming model of Tien- Fu Liang (2006). The remainder of this article is organized as follows. In the next section, the basic concepts fuzzy decisions has been implemented in mathematical programming proposed by Bellman and Zadeh (1970), in next subsection define linear member function apply in the transportation decisions problem under fuzzy sense. In section 3, the multi-objective linear programming model is considered; Tien- Fu Liang multi-objective linear programming formulation is presented.

In next section, Interactive Fuzzy Goal Programming (IFGP) algorithm and a fuzzy goal programming method explained, in third subsection interactive fuzzy linear programming will introduce. In Section 5, an illustrative example is solved using the proposed model. The test the validity and performance of the approach proposed model is discussed. Finally, some conclusions are presented in Section 6.

Prerequisite Mathematics:

Fuzzy Decision of Bellman and Zadeh (1970):

Let X be a given set of all possible solutions to a decision problem. A fuzzy goal G is a fuzzy set on X characterize by its member function

$$\mu_G: X \rightarrow [0,1], \tag{1}$$

A fuzzy constraint C is a fuzzy set on X characterize by its membership function

$$\mu_C: X \rightarrow [0,1], \tag{2}$$

Then G and C combine to generated fuzzy decision D on X, which is a fuzzy sets resulting from intersection from G and C, characterize by its membership function

$$L = \mu_D(x) = \mu_G(x) \wedge \mu_C(x) = Min(\mu_G(x), \mu_C(x)), \tag{3}$$

And corresponding maximizing decision is defined by

$$Max\ L = Max\ \mu_D(x) = Max\ (Min(\mu_G(x), \mu_C(x))), \tag{4}$$

More generally, suppose the fuzzy decision D from results k fuzzy goals $G_1, G_2, G_3, \dots, G_k$ and m constraint $C_1, C_2, C_3, \dots, C_m$. Then the fuzzy decision D is intersection $G_1, G_2, G_3, \dots, G_k$ and $C_1, C_2, C_3, \dots, C_m$, and is characterize by its membership function

$$L = \mu_D(x) = \mu_{G_1}(x) \wedge \mu_{G_2}(x) \wedge \dots \wedge \mu_{G_k}(x) \wedge \mu_{C_1}(x) \wedge \mu_{C_2}(x) \dots \wedge \mu_{C_m}(x),$$
$$= Min\ (\mu_{G_1}(x) \wedge \mu_{G_2}(x) \wedge \dots \wedge \mu_{G_k}(x) \wedge \mu_{C_1}(x) \wedge \mu_{C_2}(x) \dots \wedge \mu_{C_m}(x)), \tag{5}$$

And the corresponding maximizing decision is defined by

$$Max\ L = Max\ \mu_D(x) = Max\ Min\ (\mu_{G_1}(x),\ \mu_{G_2}(x), \dots, \mu_{G_k}(x), \mu_{C_1}(x)\mu_{C_2}(x) \dots \mu_{C_m}(x)), \tag{6}$$

Linear Membership Functions:

The corresponding linear membership function for each fuzzy objective function is defined by

$$\mu_k(Z^k(x)) = \begin{cases} 1, & if\ Z^k(x) \le L_k \\ \frac{U_k - Z^k(x)}{U_k - L_k}, & if\ L_k < Z^k(x) < U_k \\ 0, & if\ Z^k(x) \ge U_k \end{cases} \tag{7}$$

The linear membership function can be determine by requiring the DM to select the object value interval $[L_k\ ,\ U_k]$. In practical situation, a possible for vague objective value can determine base on experience of experts. Figure 1 shows the linear membership function for equation 7.

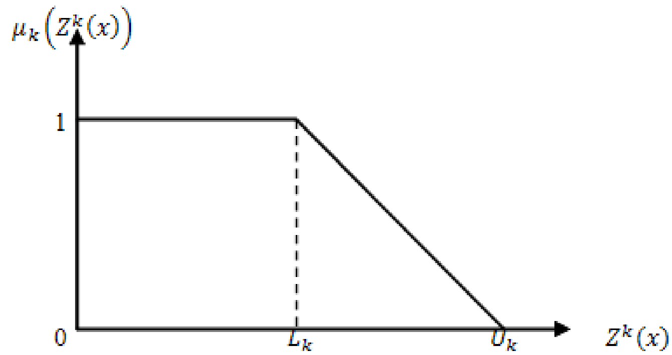

Fig. 1: Linear membership function.

3. Problem Formulation:

3.1. TPD Problem Summery Notations:

The TPD problem assume that a distribution center seek to determine transportation plan of a commodity from *m* source to *n* distention. Each source has an available supply of the commodity to disturbed different destination, and each destination has a demand of the commodity of received the sources (Tien- Fu Liang, 2006).

3.2. Objective Functions and Constraints:

In this study, objective functions in TPD multi-objective linear programming model involve three types objective, total production costs, total transportation costs and total delivery time. The aim of TPD model proposed determine optimal value to be transport from each source to each destinations to simultaneously minimize total production and total transportation and total delivery time. Two objective function were simultaneously considered in developing proposed MOTPD model presented by Tien- Fu Liang (2006) as follow as,

(P1): $Min[Z_1, Z_2] = \sum_{i=1}^{m}\sum_{j=1}^{n}(p_{ij} + c_{ij})Q_{ij} + \sum_{i=1}^{m}\sum_{j=1}^{n} t_{ij}Q_{ij}$ (8)

s.t.

$$\sum_{j=1}^{n} Q_{ij} = S_i, \qquad i = 1,2,\ldots,m \tag{9}$$

$$\sum_{i=1}^{m} Q_{ij} = D_i, \qquad j = 1,2,\ldots,n \tag{10}$$

$$Q_{ij} \geq 0, \qquad i = 1,2,\ldots,m, j = 1,2,\ldots,n \tag{11}$$

Where

z_1 total production and total transportation costs ($)

z_2 total delivery time (time)

Q_{ij} units from transported from source i to destination j (units)

p_{ij} production costs unit from source i to destination j ($/units)

c_{ij} transportation cost unit from source i to destination j ($/units)

t_{ij} transportation time unit from source i to destination j ($/units)

4. Mathematical Analysis:

4.1. Interactive Fuzzy Goal Programming (IFGP):

Accordingly, linear membership function (LMF) defines in section2.2, U_k and L_k be the upper and lower limits. in the IFGP method U_k is worst upper limit and L_k is best lower limit consider of the function k. respectively, They are calculated as follows (Abd El-Wahed, W.F., 2006):

U_k = $(Z^k)^{max} = max_{x\in X} Z^k(x)$ and (12)

$L_k = (Z^k)^{min} = min_{x\in X} Z^k(x)$, *k=1,2,…,K* (13)

By utilizing the presenting LMF and following fuzzy decision Bellman and Zadeh [5], MOTPD (P1) can be written as follow as:

(P2): *max* $\quad min_{k=1,2,\ldots,K}\left[\mu_k\left(Z^k(x)\right)\right]$

$$\text{subject to} \quad \sum_{j=1}^{n} Q_{ij} = S_i, \quad i = 1,2,\ldots,m,$$
$$\sum_{i=1}^{m} Q_{ij} = D_i, \quad j = 1,2,\ldots,n, \tag{14}$$
$$Q_{ij} \geq 0, \quad i = 1,2,\ldots,m, j = 1,2,\ldots,n$$

By introducing an auxiliary variable β problem (P2) can be transformed into the following well-known linear programming model:

(P3): $\quad max\ \beta$

$$\text{subject to} \quad \beta \leq \mu_k\left(Z^k(x)\right), k=1,2,\ldots,K,$$
$$\sum_{j=1}^{n} Q_{ij} = S_i, \quad i = 1,2,\ldots,m,$$
$$\sum_{i=1}^{m} Q_{ij} = D_i, \quad j = 1,2,\ldots,n,$$
$$Q_{ij} \geq 0, \quad i = 1,2,\ldots,m, j = 1,2,\ldots,n \tag{15}$$

To formulate problem (P3) as a goal programming model (Sakawa, M., 1993), let us introduce the following positive and negative deviational variables:

$$Z^k(x) - d_k^+ + d_k^- = G^k, k=1,2,\ldots,K,$$

Where G^k is the aspiration level of the objective function k Problem (P3) with these goals can be formulated as a mixed integer goal programming problem as follows:

(P4): $\quad max\ \beta$

$$\text{subject to} \quad \beta \leq \mu_k\left(Z^k(x)\right), k=1,2,\ldots,K,$$
$$\sum_{j=1}^{n} Q_{ij} = S_i, \quad i = 1,2,\ldots,m,$$
$$\sum_{i=1}^{m} Q_{ij} = D_i, \quad j = 1,2,\ldots,n,$$
$$Z^k(x) - d_k^+ + d_k^- = G^k, k=1,2,\ldots,K,$$
$$Q_{ij}, d_k^+, d_k^- \geq 0, \quad i = 1,2,\ldots,m, j = 1,2,\ldots,n,, k = 1,2,\ldots,K,$$
$$0 \leq \beta \leq 1,$$
$Q_{ij}$are integers $\forall_i$, j.

4.1.1. The Solution Process:

The solution procedure of problem (P4) can be summarized in the following steps.

Step 1: Develop the MOTPD as described in (P1).

Step 2: Solve the first objective function as a single objective transportation planning decision problem. Continue this process k times for the k objective functions. If all the solutions (i.e. $X^1, X^2, \ldots, X^k = \{x_{ij}\}, i = 1,2,\ldots,m, j = 1,2,\ldots,n$) are the same, select one of them as an optimum compromise solution and go to Step 8. Otherwise, go to Step 3.

Step 3: Evaluate the objective function at the *K* th solution and determine the best lower limit (L_k) and the worst upper limit (U_k).

Step 4: Define the LMF of each objective function and also the initial aspiration level.

Step 5: Develop problem (P4) and solve it as a mixed integer goal programming problem.

Step 6: Present the solution to the decision maker. If the DM accepts it, go to Step 8. Otherwise, go to Step 7.

Step 7: Evaluate each objective function of the solution. Compare the upper limit of each objective with the new value of the objective function. If the new value is lower. Than the upper bound, consider this as a new upper bound. Otherwise, keep the old one as is. Repeat this process K times and go to Step 4.

Step 8: Stop.

The solution process starts by developing a mathematical model of MOTPD to get the solution for each objective function individually. This process allows the problem solver to extension both the membership function and aspiration levels and, consequently, make the mathematical model (P4) (Abd El-Wahed W.F, 2006).

4.2. Formulation Of Fuzzy Goal Programming:
4.2.1. Fuzzy Goal Programming:

Fuzzy Goal Programming (FGP) applied the linear membership function was basically described by Narasimhan (1980). Chanas and Kuchta (2002) provide an extensive procedure survey and classification to FGP models.

A FGP mathematical model containing *K* fuzzy goals ($Z_k \quad (x)$) with solution set of *x* is defined as follows:
Optimize $Z_k(x) > G^k$ (or $Z_k(x) < G^k$) $k \in K$

$$Ax \leq b \qquad (16)$$
$$x \geq 0$$

Where $Z_k(x) > G^k$ (or $Z_k(x) < G^k$) shows that the *K*th fuzzy goal is approximately larger than or equal to (approximately smaller than or equal to) the aspiration level G^k. The linear membership function for the *K*th fuzzy goal is defined as (Zimmerman HJ. 1978):

$$\mu_k = \begin{cases} 1, & if\ Z_k(x) \geq G^k \\ \frac{Z^k(x)-L_k}{G^k-L_k}, & if\ L_k < Z_k(x) < G^k \\ 0, & if\ Z_k(x) \leq L_k \end{cases} \qquad (17)$$

For $Z_k(x) > G^k$ and as

$$\mu_k = \begin{cases} 1, & if\ Z_k(x) \leq G^k \\ \frac{U_k-Z^k(x)}{U_k-G^k}, & if\ G^k < Z_k(x) < U_k \\ 0, & if\ Z_k(x) \geq U_k \end{cases} \qquad (18)$$

Tiwari *et al.,* (1987) have proposed a weighted additive model which uses flexibility to determine the priority of the fuzzy goals. The model is defined as follows:

$$\text{Max} \sum_{k=1}^{K} W_k\, \mu_k$$

$$\mu_k \leq \frac{Z^k(x)-L_k}{G^k-L_k}\ (or \mu_k \leq \frac{U_k-Z^k(x)}{U_k-G^k})$$

$$Ax \leq b$$

$$x, \mu_k \geq 0 \quad k \in K \qquad (19)$$

$$\mu_k \leq 1 \quad k \in K$$

Where W_k is the weight of the *K*th fuzzy goal constraint and

$$\sum_{k=1}^{K} W_k = 1 \ \ k \in K \qquad (20)$$

is the achievement degree of the *K*th fuzzy goal.

4.2.2. Proposed FTPD Model:

In this study, the goals which are presented at Section 3.2 are considered as the fuzzy sense.

The first fuzzy goal is consist of total production and total transportation costs that is approximately smaller than or equal to z_1^l :

$$Z_1 = \sum_{i=1}^{m} \sum_{j=1}^{n} (p_{ij} + c_{ij}) Q_{ij} \leq Z_1^l \qquad (21)$$

The second fuzzy goal is the total delivery time approximately smaller than or equal to Z_2^l :

$$Z_2 = \sum_{i=1}^{m} \sum_{j=1}^{n} t_{ij} Q_{ij} \leq Z_2^l \qquad (22)$$

Assume that Z_1^u and Z_2^u are the upper tolerance bound, Z_1^l and Z_2^l are the lower tolerance bound of the fuzzy goals Z_1 and Z_2 imposed by the decision maker(s), respectively. The linear membership function for the *K*th fuzzy goal is defined as follows (U_gur ¨ Ozcana, 2009):

$$\mu_{Z_1} = \begin{cases} 1, & if\ Z_1 \le Z_1^l \\ \frac{Z_1^u - Z_1}{Z_1^u - Z_1^l}, & if\ Z_1^l < Z_1 < Z_1^u \\ 0, & if\ Z_1 \ge Z_1^u \end{cases} \quad (23)$$

$$\mu_{Z_2} = \begin{cases} 1, & if\ Z_2 \le Z_2^l \\ \frac{Z_2^u - Z_2}{Z_2^u - Z_2^l}, & if\ Z_2^l < Z_2 < Z_2^u \\ 0, & if\ Z_2 \ge Z_2^u \end{cases} \quad (24)$$

The fuzzy goals are then converted to the following formulations:

$$\mu_{Z_1} \le \frac{Z_1^u - Z_1}{Z_1^u - Z_1^l} \quad (25)$$

$$\mu_{Z_2} \le \frac{Z_2^u - Z_2}{Z_2^u - Z_2^l} \quad (26)$$

$$0 \le \mu_{Z_1}, \mu_{Z_2} \le 1 \quad (27)$$

Finally, the proposed FMIGP (Fuzzy Mix Integer Goal Programming) model for TPD problem with fuzzy multi - objectives is formulated as follows (U_gur ¨ Ozcana, 2008):

$$Max\ f(\mu) = W_1.\mu_{Z_1} + W_2.\mu_{Z_2} \quad (28)$$

Subject to
Fuzzy goal constraints:

$$(Z_1^u - Z_1^l)\mu_{Z_1} + \sum_{i=1}^{m}\sum_{j=1}^{n}(p_{ij} + c_{ij})Q_{ij} - Z_1^u \le 0 \quad (29)$$

$$(Z_2^u - Z_2^l)\mu_{Z_2} + \sum_{i=1}^{m}\sum_{j=1}^{n} t_{ij}Q_{ij} - Z_2^u \le 0 \quad (30)$$

4.3. Interactive Fuzzy Linear Programming (I-FMOLP) Approach:

The crisp multi-objective linear programming TPD problem presented in section 3.0 can be solved using fuzzy decision-making of Bellman and Zadeh (1970). The linear membership functions are characterized to show the fuzzy sets encompassed. Then, by introducing the auxiliary variable β the crisp multi-objective linear programming TPD problem duplicated with equivalent single-objective LP problem. The multi-objective linear programming TPD problem can be formulated as follow (Tien- Fu Liang, 2006):

$\max \beta$

s.t.

$$\begin{aligned} & \beta \le \mu_k(Z^k(x)), \\ & \sum_{j=1}^{n} Q_{ij} = S_i, \quad i = 1,2,\dots,m \\ & \sum_{i=1}^{m} Q_{ij} = D_i, \quad j = 1,2,\dots,n \\ & Q_{ij} \ge 0, \quad i = 1,2,\dots,m, j = 1,2,\dots,n \end{aligned} \quad (31)$$

where the variable β is degree of DM satisfaction with the obtain multi-objective quantities.

The solution procedure introduce as follow (Tien- Fu Liang, 2006):

Step 1: Formulate the crisp fuzzy MOLP model for the TPD problems.

Step 2: Determining LMF (Linear Membership Function) for whole of the objective functions.

Step 3: Introduce the auxiliary variable β, and aggregate the crisp fuzzy MOLP problem in to an equivalent ordinary single objective LP model using the minimum operator.

Step 4: Solve the LP problem and obtain initial compromise solutions.

Step 5: Execute and interactive decision process. If DM not satisfied with the initial compromise solution, the model must be change until satisfactory solution found.

5. Computational Example:

5.1. An Application Example Of IFGP Method:

To illustrate the interactive fuzzy goal programming approach steps, According below table data, we consider the following an example of TPD problem [taken from (Tien- Fu Liang, 2006)]:

Table 1: Data involving Supply and Demand Values and Objective Coefficients (Z_1, Z_2) in TPD problem.

Source $(\boldsymbol{S_i})$	Destinations					Supply
	1	2	3	4	5	
1	\$10/6hours	\$12/8hours	\$16/12hours	\$20/16hours	30/40	18
2	\$12/10	\$7/10	\$13/15	\$24/22	\$36/32	24
3	\$14/12	\$16/16	\$20/18	\$10/10	\$32/30	10
Demand $(\boldsymbol{D_i})$	10	8	12	16	6	52

Based on the solution procedure presented in Section 4.1.1, the final aspiration levels of the two objective functions are 724 and1326, respectively. Thus, the upper and lower limits in the linear membership function will be 724 and1326, Based on these modifications, we obtain with mix integer goal programming model (P4). Then, we will solve FMIGP model by LINGO software (Ver. 10.0). Finally, we get the following compromise solution:

β=0.0792, Q_{11}=10, Q_{12}= 0, Q_{13} = 0, Q_{14}= 6, Q_{15}=2, Q_{21}= 0, Q_{22}= 8, Q_{23}=12, Q_{24}= 0, Q_{25}= 4, Q_{31}=0, Q_{32}= 0, Q_{33}= 0, Q_{34}=10, Q_{35}= 0, d_1^-= 0, d_2^-= 0

The DM accepts this solution because we reach aspersion levels and deviation variables equal is zero.
Therefore, mathematical TPD problem obtain compromise solution, but this solution isn't ideal solution. We measure distance with optimum solutions in subsection 5.4. When TPD mathematical model resolved by new upper and lower limits, we haven't influence on Q_{ij} values, but β variable and deviation variables (d_1^-, d_2^-) values have change.

5.2. An Application Example Of FGP Method In 4.2:

In this section, we consider one application example TDP problem. The lower limits (Z_1^l, Z_2^l) and upper limits (Z_1^u, Z_2^u) of fuzzy goals Z_1 and Z_2 are 1200, 600 and 2400,800. The linear membership functions of the fuzzy goals of this problem are calculated using expressions (23) and (24) with the lower and upper limits of the fuzzy goals. The weights of the achievement degrees of the fuzzy goals are the same and the sum of the weights is equal to 1, so that the weights are $w_1 = w_2 = \frac{1}{2}$, In TPD problem, the fuzzy goal programming model for the example problem is as follows:

$$\text{Max Z}= \frac{1}{2}\mu_{Z_1} + \frac{1}{2}\ \mu_{Z_2} \tag{32}$$

s.t.

$$34\mu_{Z_1}+25Q_{11} + 27Q_{12} + 31Q_{13} + 35Q_{14} + 45Q_{15} + 22Q_{21} + 17Q_{22} + 23Q_{23} + 34Q_{24} + 46Q_{25} + 22Q_{31} + 24Q_{32} + 28Q_{33} + 18Q_{34} + 40Q_{35} \le 1344 \tag{33}$$

$$70\mu_{Z_2}+ 6Q_{11} + 8Q_{12} + 12Q_{13} + 16Q_{14} + 40Q_{15} + 10Q_{21} + 10Q_{22} + 15Q_{23} + 22Q_{24} + 32Q_{25} + 12Q_{31} + 16Q_{32} + 18Q_{33} + 10Q_{34} + 30Q_{35} \le 772 \tag{34}$$

$$0 \le \mu_{Z_1}, \mu_{Z_2} \le 1\ ,\ Q_{ij} \ge 0$$

The fuzzy goal programming model for example transportation decision planning problem is solved by the LINGO software. The outputs this model shown as follows:

$\mu_{Z_1} = 1.0$, Q_{11}=3, Q_{12}=3, Q_{13} =12, Q_{14}=0, Q_{15}=0, Q_{21}=7, Q_{22}=5, Q_{23}=0, Q_{24}=6, Q_{25}=6, Q_{31}=0, Q_{32}= 0, Q_{33}= 0, Q_{34}=10, Q_{35}= 0, $\mu_{Z_2} = 1.0$

Accordingly these results, membership degree both objective function 1(Z_1) and objective function 2 (Z_2) reach maximum level consequently, we obtain compromise solutions, as result of satisfaction degree DM provide. Base on optimal quantities (Q_{ij}^*), aspiration levels function objectives quantity equal to $Z_1 = 1424$ and Z_2=730.

5.3. An Application Example For Interactive Multi-Objective Linear Programming (I-FMOLP):

To illustrate the i-FMOLP steps, let us consider the following of TPD problem (taken from 15). Accordingly solution procedure that we have presented in section 4.3. The lower limits (Z_1^l, Z_2^l) and upper limits (Z_1^u, Z_2^u) of fuzzy goals Z_1 and Z_2 are 1200, 600 and 2400, 2000. The TPD problem is solved using the LINGO software, thus the following compromise solutions as follows:

β=0.9271, Q_{11}=10, Q_{12}= 0, Q_{13} = 0, Q_{14}= 6, Q_{15}=2, Q_{21}= 0, Q_{22}= 8, Q_{23}=12, Q_{24}= 0, Q_{25}= 4, Q_{31}=0, Q_{32}= 0, Q_{33}= 0, Q_{34}=10, Q_{35}= 0,

Base on above solutions, solutions i-FMOLP method similar to IFGP method compromise solutions, but β satisfaction degree DM in i-FMOLP method more than IFGP method. The optimal function objectives quantity equal to $Z_1 = 1344$ and Z_2=702.

Conclusion:

In this paper, three different methods presented for solving multi-objective Transportation decision planning (TPD) problem with multiple fuzzy goals. The IFGP method focuses on minimizing the worst upper limits to obtain an efficient solution which is close to the best lower limit of each objective function. Upper and lower limits updated by resolve model in different loops, when solution reach compromise solution and supply satisfaction degree DM. in these conditions, deviation variables equal is zero and we reach aspiration level. Second approach is FGP method; it is capable of simultaneously optimizing more than one conflicting goal by using the weighted achievement degrees of the fuzzy goals. Third approach is i-FMOLP, this method aim minimize both total costs and time delivery time. The proposed i-FMOLP method, yield and efficient compromise solution and provide satisfaction degree DM in maximum levels. Accordingly Fig 2, i-FMOLP approach is a powerful method to determine appropriate aspiration levels of the objective functions. The performance of the suggested approach was comprised using a set of metric distance functions with respect to the IFGP and FGP methods .The main advantage i-FMOLP approach as follow; upper and lower limits updated by DM opinions and this action cause to more will modify aspiration levels, although in IFGP method modify aspiration levels using resolve mathematical modeling in different loops and this action less efficient relativity with i-FMOLP approach. As result of, i-FMOLP method more suitable than IFGP and FGP methods for solving TPD problem with fuzzy goals. For future research can i-FMOLP method developed in production planning, Supplier selection and inventory management multi objective linear programming models and other multi-objective decision making methods.

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